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ABSTRACT

The Third International Mathematics and Science Study (TIMSS) provides comparative assessments of student outcomes, instructional practices, curricula, and cultural contexts. The state of Minnesota participated in the study as a 'mini nation' and this document is a preliminary report of the results. This summary provides a picture of the performances of almost 5,000 Minnesota students as compared to their peers around the world in science and mathematics. The results of the study will help to shape education policy and implement the Minnesota Graduation Standards. This report provides details on Minnesota eighth grade achievement results compared to those of the whole United States and other nations in mathematics and science content areas, a summary of contextual factors impacting mathematics and science achievement, sample items, gender differences in eighth grade mean achievement, and recommendations for change in policy and practice. (DDR)

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ED 408 157

SCI MATH MN

MINNESOTA TIMSS REPORT

A PRELIMINARY SUMMARY OF RESULTS

THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

MINNESOTA SCIENCE AND MATH COMPARED INTERNATIONALLY IN TIMSS

The Third International Mathematics and Science Study (TIMSS) is the largest, most thorough international study of mathematics and science education ever conducted; 41 countries, including the U.S., participated in student testing and surveys of school practices. The National Center for Education Statistics (NCES) of the U.S. Department of Education, The National Science Foundation (NSF) and the Canadian Government funded TIMSS, which provides comparative assessments of student outcomes, instructional practices, curricula, and cultural context.

SciMath^{MN} sponsored Minnesota's participation as a 'mini-nation' in TIMSS, and thus has produced this preliminary summary of Minnesota results. A more complete report will be available in late spring 1997, providing greater detail and analysis on how Minnesota students compare to their peers around the world in science and mathematics, and the factors that impact student performance. The Minnesota TIMSS results will be helpful in shaping critical K-12 education policy and in implementing the Minnesota Graduation Standards.

TIMSS assessed nearly 34,000 U.S. students in grades 3-4, 7-8 and 12, including the almost 5,000 students who participated in the Minnesota comparison. The initial U.S. findings, released by NCES in November 1996 in *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context*, showed the U.S. slightly above the international average in science and slightly below in mathematics.

SUMMARY OF MINNESOTA EIGHTH GRADE ACHIEVEMENT RESULTS

The performance of Minnesota eighth grade students in mathematics and science achievement reflects both strengths and weaknesses.

- Minnesota eighth-graders scored about the international average in mathematics.
- They scored well above the international average in science (among the top countries).
- They scored above the U.S. average in all specific content areas but showed the same wide range of individual scores.

Being among the best in the U.S. is not the same as being first in the world.

- Minnesota's consistently strong performance in mathematics and science compared to the rest of the U.S. looks different in an international context.
- Eighth grade mathematics in Minnesota is seventh grade mathematics by international standards.
- As the recent results on U.S. NAEP testing show, some Minnesota students--particularly some minority groups--still lag far behind their peers in mathematics achievement at the eighth grade, a fact hidden by the single average Minnesota score for mathematics on the TIMSS tests.

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Figure 1. Minnesota's Average Eighth Grade Mathematics Performance Compared to the U.S. and other nations

Nations with Average Scores Significantly Higher than Minnesota	
Singapore	643
Korea	607
Japan	605
Hong Kong	588
Belgium-Flemish	565
Czech Republic	564

Nations with Average Scores Not Significantly Different from Minnesota	
Slovak Republic	547
Switzerland	545
Netherlands	541
Slovenia	541
Bulgaria	522
Austria	539
France	538
Hungary	537
Russian Federation	535
Australia	530
Ireland	527
Canada	527
Belgium-French	526
MINNESOTA	**525**
Sweden	519
Thailand	522
Israel	522
Germany	509
New Zealand	508
England	506
Norway	503
Denmark	502
UNITED STATES	**500**
Scotland	498

◀ 513

◀ International Average = 513

Nations with Average Scores Significantly Lower than Minnesota	
Latvia	493
Spain	487
Iceland	487
Greece	484
Romania	482
Lithuania	477
Cyprus	474
Portugal	454
Iran, Islamic Rep.	428
Kuwait	392
Colombia	385
South Africa	354

Figure 2. Minnesota's Average Eighth Grade Science Performance Compared to the U.S. and other nations

Nations with Average Scores Significantly Higher than Minnesota	
Singapore	607

Nations with Average Scores Not Significantly Different from Minnesota	
Czech Republic	574
Japan	571
Korea	565
Bulgaria	565
MINNESOTA	**565**
Netherlands	560
Slovenia	560
Austria	558
Hungary	554
England	552
Belgium-Flemish	550
Australia	545
Slovak Republic	544
Russian Federation	538
Ireland	538

◀ International Average = 516

Nations with Average Scores Significantly Lower than Minnesota	
Sweden	535
UNITED STATES	**534**
Germany	531
Canada	531
Norway	527
New Zealand	525
Thailand	525
Israel	524
Hong Kong	522
Switzerland	522
Scotland	517
Spain	517
France	498
Greece	497
Iceland	494
Romania	486
Latvia (LSS)	485
Portugal	480
Denmark	478
Lithuania	476
Belgium-French	471
Iran, Islamic Rep.	470
Cyprus	463
Kuwait	430
Colombia	411
South Africa	326

◀ 516

We cannot ascribe Minnesota's relative success (compared to the rest of the U.S.) to our homogeneous population.

- The range of student scores from top to bottom in Minnesota is similar to the range of scores for all U.S. students.

- The high average performance in science and middling performance in mathematics were achieved essentially by the same group of students (in other words, we have to look to factors other than student background or socio-economic standing to account for the difference in scores between mathematics and science).

- Unlike the U.S. results, there was a significant difference in performance between boys and girls in science (though not in mathematics) in the Minnesota TIMSS testing.

TIMSS shows the importance of focus in curricular materials and instructional practices.

- We are lowest in measurement and geometry in large part because we emphasize arithmetic, without focus on geometry and measurement.

- We score high in earth sciences and life sciences primarily because we emphasize these subjects at the seventh and eighth grade levels.

Minnesota did particularly well in science (on TIMSS) primarily because the major factors contributing to success were relatively well aligned.

- Course offerings are consistent statewide (eighth grade science in Minnesota is earth science, the content area we scored highest in), and a majority of teachers use the same or similar textbooks.

- There is little tracking in eighth grade science, as compared to eighth grade mathematics.

- Teacher licensing supports the curriculum focus.

- The tradition of inquiry-oriented instruction and the long-standing availability of appropriate materials (kits, etc.) also help explain Minnesota's strong showing in science.

The focus and coherence of the components of the system, not any one part of the system in isolation, make the difference in how Minnesota performs as a whole.

- The international TIMSS results show that it's not who is taking the test, or how much homework or time on task students have, or length of school day or school year, that makes the biggest difference in student performance.

- The U.S. performance on TIMSS shows the weaknesses of an unfocused curriculum and instructional approaches, further complicated by use of diverse and unaligned assessments.

- Minnesota's performance on TIMSS illustrates the power of alignment (as reflected in our science scores) and the problems with lack of focus (as reflected in our mathematics performance).

- Even in science, we still need to improve -- to move beyond traditional approaches and to close the gender gap (and similar performance gaps which may exist for other under-performing groups of students).

- The national standards provide a potentially powerful source of direction and focus for Minnesota mathematics and science, but the danger is uneven implementation (some districts use the standards, some don't) or burden by addition (adding recommendations from the standards without taking anything away from the existing curriculum).

Figure 3. Nations Average Percent Correct In Mathematics Content Areas, With Minnesota Averages
Third International Mathematics and Science Study (TIMSS)

Significantly more than Minnesota
Not significantly different than Minnesota
Significantly less than Minnesota

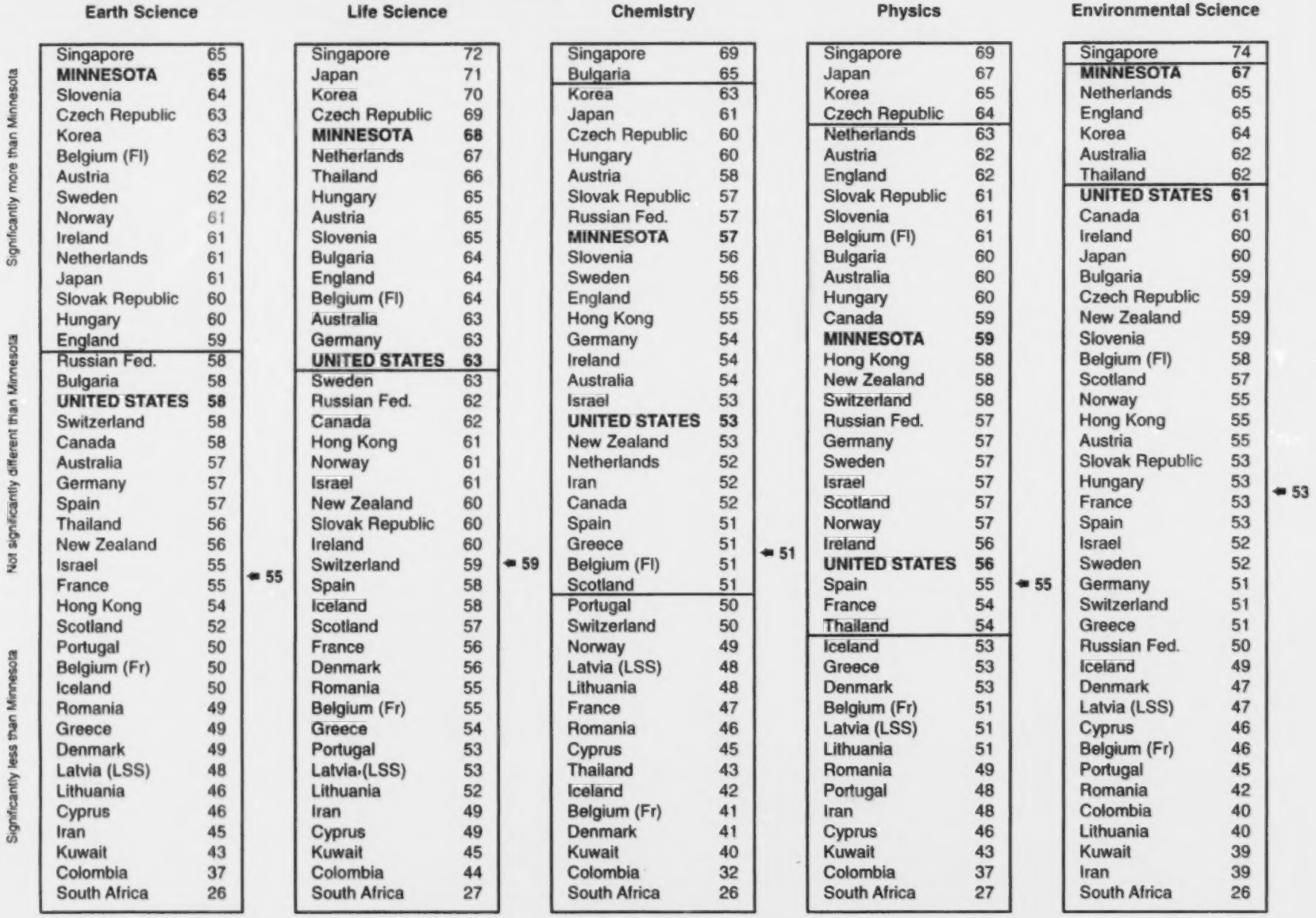
Fractions & Number Sense		Measurement		Geometry		Proportionality		Algebra		Data Representation, Analysis, Probability	
Singapore	84	Singapore	77	Japan	80	Singapore	75	Singapore	76	Singapore	79
Japan	75	Japan	67	Singapore	76	Hong Kong	62	Japan	72	Korea	78
Korea	74	Korea	66	Korea	75	Korea	62	Hong Kong	70	Japan	78
Hong Kong	72	Hong Kong	65	Hong Kong	73	Japan	61	Korea	69	Belgium (Fl)	73
Belgium (Fl)	71	Czech Republic	62	Czech Republic	66	Belgium (Fl)	53	Czech Republic	65	Switzerland	72
Czech Republic	69	Austria	62	France	66	Switzerland	52	Hungary	63	Netherlands	72
Switzerland	67	Switzerland	61	Bulgaria	65	Czech Republic	52	Russian Fed.	63	Hong Kong	72
Slovak Republic	66	Slovak Republic	60	Belgium (Fl)	64	Netherlands	51	Belgium (Fl)	63	France	71
Austria	66	Belgium (Fl)	60	Russian Fed.	63	Thailand	51	Slovak Republic	62	**MINNESOTA**	**71**
Ireland	65	Slovenia	59	Slovak Republic	63	Ireland	51	Bulgaria	62	Sweden	70
Hungary	65	Netherlands	57	Thailand	62	Slovenia	49	Slovenia	61	Ireland	69
France	64	France	57	Slovenia	60	Slovak Republic	49	Israel	61	Canada	69
Canada	64	Hungary	56	Hungary	60	Austria	49	Austria	59	Austria	68
MINNESOTA	**64**	Russian Fed.	56	Switzerland	60	France	49	**MINNESOTA**	**58**	Czech Republic	68
Slovenia	63	Sweden	56	Netherlands	59	Russian Fed.	48	Australia	55	Belgium (Fr)	68
Sweden	62	Belgium (Fr)	56	Belgium (Fr)	58	Canada	48	Spain	54	Australia	67
Belgium (Fr)	62	Bulgaria	54	Canada	58	Belgium (Fr)	48	France	54	Denmark	67
Russian Fed.	62	Australia	54	Australia	57	Bulgaria	47	Canada	54	Norway	66
Netherlands	62	Ireland	53	Israel	57	Australia	47	Ireland	53	New Zealand	66
Australia	61	Norway	51	Austria	57	Hungary	47	Belgium (Fr)	53	Slovenia	66
Israel	60	Canada	51	Latvia (LSS)	57	**MINNESOTA**	**45**	Thailand	53	England	66
Bulgaria	60	Germany	51	New Zealand	54	Sweden	44	Switzerland	53	Hungary	66
Thailand	60	Thailand	50	England	54	Israel	43	Netherlands	53	**UNITED STATES**	**65**
UNITED STATES	**59**	England	50	Denmark	54	New Zealand	42	Romania	52	Scotland	65
Germany	58	Denmark	49	**MINNESOTA**	**54**	**UNITED STATES**	**42**	**UNITED STATES**	**51**	Germany	64
Norway	58	New Zealand	48	Lithuania	53	Germany	42	Latvia (LSS)	51	Israel	63
New Zealand	57	Israel	48	Romania	52	Romania	42	New Zealand	49	Iceland	63
Iceland	54	Scotland	48	Scotland	52	England	41	England	49	Thailand	63
England	54	Romania	48	Ireland	51	Denmark	41	Germany	48	Bulgaria	62
Scotland	53	Latvia (LSS)	47	Germany	51	Norway	40	Cyprus	48	Slovak Republic	62
Denmark	53	**MINNESOTA**	**47**	Iceland	51	Spain	40	Lithuania	47	Russian Fed.	60
Greece	53	Iceland	45	Norway	51	Scotland	40	Scotland	46	Spain	60
Latvia (LSS)	53	Spain	44	Greece	51	Cyprus	40	Greece	46	Greece	56
Spain	52	Cyprus	44	Spain	49	Greece	39	Norway	45	Latvia (LSS)	56
Lithuania	51	Greece	43	Sweden	48	Latvia (LSS)	39	Denmark	45	Portugal	54
Cyprus	50	Lithuania	43	**UNITED STATES**	**48**	Iceland	38	Sweden	44	Cyprus	53
Romania	48	**UNITED STATES**	**40**	Cyprus	47	Iran	36	Iceland	40	Lithuania	52
Portugal	44	Portugal	39	Portugal	44	Lithuania	35	Portugal	40	Romania	49
Iran	39	Iran	29	Iran	43	Portugal	32	Iran	37	Iran	41
Colombia	31	Colombia	25	Kuwait	38	Colombia	23	Kuwait	30	Kuwait	38
Kuwait	27	Kuwait	23	Colombia	29	South Africa	21	Colombia	28	Colombia	37
South Africa	26	South Africa	18	South Africa	24	Kuwait	21	South Africa	23	South Africa	26

← 58 (Fractions & Number Sense)
← 51 (Measurement)
← 56 (Geometry)
← 45 (Proportionality)
← 52 (Algebra)
← 62 (Data Representation, Analysis, Probability)

← International Average Percent

SciMath[MN] Preliminary Summary of MN TIMSS Results, March 1997

Figure 4. Nations Average Percent Correct In Science Content Areas, With Minnesota Averages
Third International Mathematics and Science Study (TIMSS)



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8

International Average Percent

SciMath[MN] Preliminary Summary of MN TIMSS Results, March 1997

Figure 5. Percentiles of Achievement in Mathematics (Eighth Grade)

Country	5th Percentile	25th Percentile	75th Percentile	95th Percentile
Singapore	499	584	704	792
Minnesota	**388**	**464**	**586**	**671**
U.S.	356	435	563	653
South Africa	259	313	386	484

Figure 6. Percentiles of Achievement in Science (Eighth Grade)

Country	5th Percentile	25th Percentile	75th Percentile	95th Percentile
Singapore	457	541	674	768
Minnesota	**401**	**502**	**631**	**726**
U.S.	359	465	608	705
South Africa	185	261	376	526

Figure 7. Percentages of Eighth Grade Students Achieving at Least the International Median in Mathematics

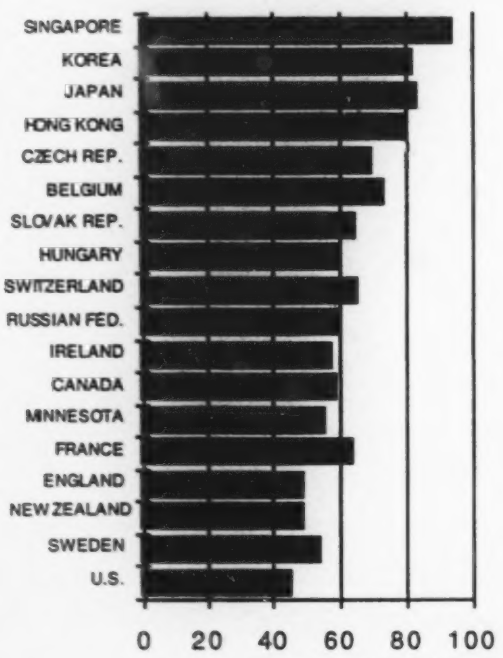
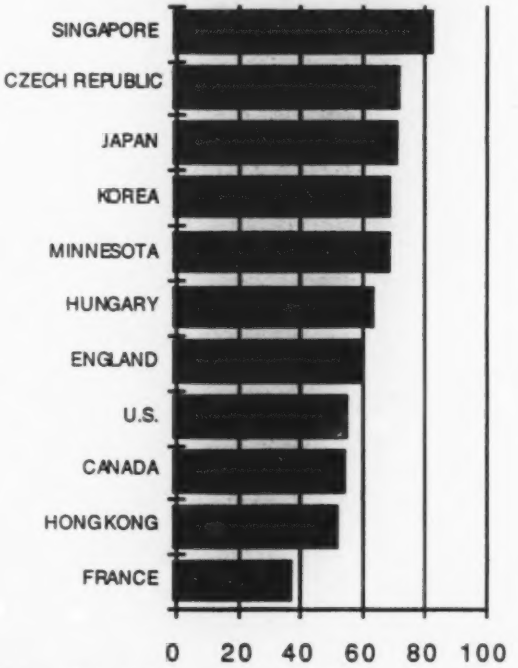


Figure 8. Percentages of Eighth Grade Students Achieving at Least the International Median in Science



SOURCE: IEA Third International Mathematics and Science Study, 1994-95.

SUMMARY OF CONTEXTUAL FACTORS IMPACTING MATHEMATICS ACHIEVEMENT

Minnesota mathematics classrooms look a lot like mathematics classrooms in other parts of the United States. Because our teachers are well qualified and our students are largely interested in learning, achievement for Minnesota eighth graders is superior to most other states and the United States average. However, compared to international standards, the achievement of Minnesota students is not outstanding. Here are some findings from TIMSS questionnaire data which are related to the achievement results.

The content of Minnesota eighth grade mathematics courses is less rigorous than that in most other countries.

Finding: Minnesota eighth grade curriculum continues to focus largely on number. Students in other countries are studying algebra and geometry.

Finding: Topics that were covered in earlier grades are those most likely to be studied again in ALL eighth grade classes; topics that are new at the eighth grade level are least likely to be covered.

Ability grouping or tracking reduces the opportunity for many students to learn rigorous mathematics.

Finding: About half of the eighth graders in Minnesota study traditional eighth grade mathematics, largely a repetition of earlier grades; about one-fourth study pre-algebra; and about one-fourth study algebra, which is more than in many other states, but far less than in most countries.

Finding: About one school in five provides all eighth grade students with the same mathematics course.

Finding: More than half of Minnesota schools provide three to five levels of eighth grade mathematics.

Finding: Academic performance is a very important factor in how students are grouped in schools; this suggests that the more a student already knows, the more he or she has an opportunity to learn, while students who know less are given less opportunity to learn.

The content of Minnesota eighth grade mathematics courses is less coherent than the content in most other countries.

Finding: Most other countries select a small number of topics to study in depth each year (typically 5-8).

Finding: Most K-8 texts in the United States cover many topics each year, spending a short amount of time on each.

Finding: A typical Minnesota eighth grade mathematics class lesson (i.e., a single class period) includes an average of 3.5 topics.

Classroom activities do not reflect learnings from cognitive science and brain research about successful learning experiences. These include the necessity for communication and active engagement by the learners.

Finding: Despite familiarity with current national and state recommendations and research emphasizing the importance of communicating mathematically, few Minnesota eighth grade mathematics teachers ask students to engage in such activities. For example,

- four out of five rarely or never ask students to work on a project
- almost three-fourths rarely or never ask students to engage in an investigation
- about two-thirds rarely or never ask students to read a text
- more than three-fourths rarely or never ask students to write mathematics
- 92% rarely or never ask students to give an oral report
- 98% rarely or never ask students to write in journals

Finding: According to students, the least frequent classroom activities are:

- working with computers
- working on projects
- connecting mathematics to everyday things
- working in pairs or small groups

Finding: According to students, the most frequent classroom activities are:
- teacher demonstration of problems
- worksheets and individual work

Finding: More than two out of five Minnesota eighth grade mathematics teachers use worksheets to supplement work in textbooks.

Finding: Though almost all Minnesota students feel learning mathematics is important in life, and a majority enjoy learning mathematics and find it easy, almost half find mathematics class boring.

Teachers' work lives do not exhibit characteristics of other professional communities; they work in isolation, without benefit of feedback or advice from peers.

Finding: Minnesota teachers, like those throughout the United States, teach an average of 30 hours a week compared to teachers in other countries, who teach an average of 20 hours a week. There is comparatively less time to interact with other educators.
- Three-fourths of Minnesota eighth grade mathematics teachers have never visited another teacher's class; more than half have never had another teacher visit their class.
- Three-fourths of Minnesota eighth grade mathematics teachers rarely or never confer with another teacher or curriculum specialist in planning a lesson.
- Only two out of five Minnesota eighth grade mathematics teachers meet with other teachers to discuss mathematics at least once a month. More than two out of five do this twice a year or less often.

Finding: Administrators overwhelmingly believe that teachers in their school are encouraged to share with colleagues, and to meet on a regular basis to discuss instruction.

Like many states, Minnesota has no mandated state curriculum. While districts are required to develop curriculum goals at the local level, the default curriculum guide is the current textbook in use.

Finding: Two-thirds of Minnesota eighth grade mathematics teachers use the textbook to determine what they will teach in the course.

Finding: More than three-fourths use the text to determine how to present a topic, to plan lessons, and to select problems for class, homework and assessments.

Finding: Most administrators believe that curriculum decisions are made mainly by teachers; only 6% believe that text publishers greatly influence curriculum decisions.

Other findings of interest:

Finding: Minnesota teachers of mathematics, like those in the United States, are better trained in their subject area than educators in other countries.

Finding: 99.6% of Minnesota eighth grade mathematics students report having one or more calculators in their home; 65% of the students report having a computer in their home.

Conclusion:
Minnesota eighth grade mathematics teachers are well prepared, qualified and are successful in meeting the expectations of the public and the educational community. Nevertheless, in order to make the changes which will help students become more successful in our global economy, those expectations will have to change and teachers will need long term support and carefully planned opportunities for ongoing, focused and sustained professional development. This will include support for:

- learning new content
- establishing collaborative learning communities with colleagues
- implementing new instructional materials which are more rigorous, focused and coherent, and
- using a broader range of effective instructional strategies.

Given Minnesota's move toward results-based education, inquiry-oriented classrooms and performance assessment, this picture of Minnesota eighth grade mathematics classrooms suggests that a great deal of change needs to take place within mathematics education in the near future.

MATHEMATICS SAMPLE ITEMS

EXAMPLE ITEM 1
FRACTIONS & NUMBER SENSE

A car has a fuel tank that holds 35 L of fuel. The car consumes 7.5 L of fuel for each 100 km driven. A trip of 250 km was started with a full tank of fuel. How much fuel remained in the tank at the end of the trip?

(A) 16.25 L

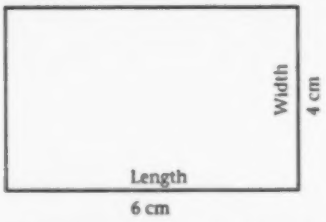
B. 17.65 L

C. 18.75 L

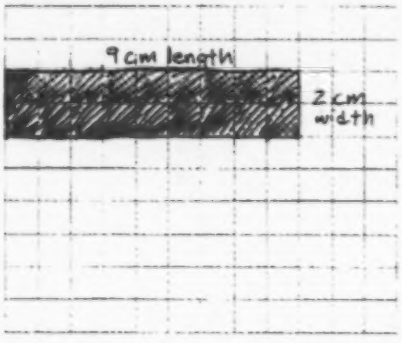
D. 23.75 L

International Average Percent Correct (8th Grade)	
Item 1	39
Item 2	31
Item 3	58
Item 4	65

EXAMPLE ITEM 2
MEASUREMENT



In the space below, draw a new rectangle whose length is one and one-half times the length of the rectangle above, and whose width is half the width of the rectangle above. Show the length and width of the new rectangle in centimeters on the figure.



EXAMPLE ITEM 3
ALGEBRA

If m represents a positive number, which of these is equivalent to $m + m + m + m$?

A. $m + 4$

(B) $4m$

C. m^4

D. $4(m+1)$

EXAMPLE ITEM 4
PROPORTIONALITY

Three-fifths of the students in a class are girls. If 5 girls and 5 boys are added to the class, which statement is true of the class?

(A) There are more girls than boys.

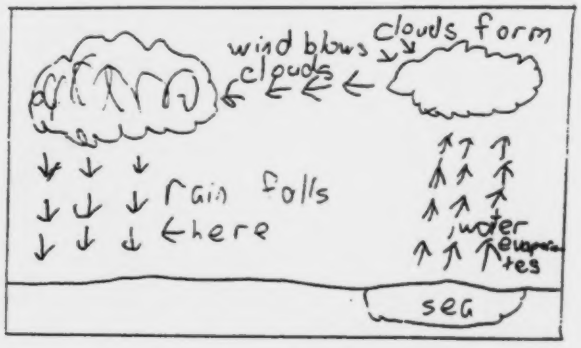
B. There are the same number of girls as there are boys.

C. There are more boys than girls.

D. You cannot tell whether there are more girls or boys from the information given.

EXAMPLE ITEM 5
EARTH SCIENCE

Draw a diagram to show how the water that falls as rain in one place may come from another place that is far away.

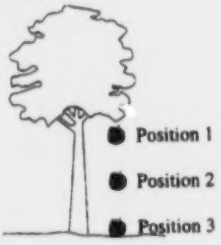


International Average Percent Correct (8th Grade)	
Item 5	32
Item 6	55
Item 7	50

EXAMPLE ITEM 6
PHYSICS

The drawing shows an apple falling to the ground. In which of the three positions does gravity act on the apple?

A. 2 only
B. 1 and 2 only
C. 1 and 3 only
D. 1,2 and 3



EXAMPLE ITEM 7
CHEMISTRY

Carbon dioxide is the active material in some fire extinguishers. How does carbon dioxide extinguish a fire?

A fire needs oxygen to burn so a fire extinguisher sprays out the carbon dioxide to replace the presence of oxygen without oxygen, a fire can't burn.

SUMMARY OF CONTEXTUAL FACTORS IMPACTING SCIENCE ACHIEVEMENT

Minnesota eighth grade science curriculum is very focused on earth science.

Finding: Earth Processes, Earth Features, Earth in the Universe, and Environmental and Resource Issues are the topics being taught in the majority of Minnesota eighth grade science classrooms.

Finding: 73% of Minnesota eighth grade science teachers report using a textbook to teach earth science.

Minnesota eighth grade teachers extensively supplement the textbook material.

Finding: 54% of Minnesota eighth grade science teachers base their teaching on a text less than half the time.

Finding: Two of every three teachers supplement the curriculum with lab activities gathered from a variety of sources.

Finding: Two in three eighth grade students report doing an experiment or practical investigation almost always.

Minnesota science courses are heavily content based, with little emphasis on scientific inquiry.

Finding: One teacher in four reports they never ask students to work on problems for which there is no immediate solution.

Finding: 2 in 5 eighth grade students report that they almost always begin a new topic in science by having the teacher explain rules and definitions.

Finding: 84% of students report they often work on their own from worksheets or textbooks.

Finding: Although most science teachers report that they engage their students in lab activities, most students are not given the opportunity to conduct full scientific inquiry investigations.

- 48% of the teachers agree that it is important to give students prescriptive and sequential directions for doing science experiments.
- 100% of Minnesota eighth grade science teachers say it is important for students to provide reasons to support their conclusions, yet one third of the teachers spend less than five class periods on organizing and interpreting data.

Minnesota eighth graders enjoy learning science.

Finding: 94% of Minnesota eighth graders agree or strongly agree that it is important to do well in science at school.

Finding: 72% of Minnesota eighth graders admit that they enjoy learning science.

Finding: More than 85% of Minnesota students believe that the application of science can help in addressing environmental problems.

Minnesota science teachers report some limitations to teaching science in Minnesota.

Finding: 39% of teachers report that they are limited by a shortage of instructional equipment for student use.

Finding: 29% report that they are limited by inadequate facilities.

Finding: Four in ten science teachers report that they are limited by high student/teacher ratios.

Finding: One-half of the teachers report that a shortage of computer equipment and software limits their teaching.

By eighth grade there is already a gender gap in achievement in the sciences.

Finding: While the Minnesota average achievement score in science is above average, eighth grade boys significantly outscore girls in science achievement. This is not true for the U.S. as a whole.

Finding: The greatest science achievement difference between genders is in the physical sciences, while boys and girls score about the same in life science and environmental science.

Teachers' work lives do not exhibit characteristics of other professional communities.

Finding: 59% of Minnesota science teachers never or rarely confer with other teachers or science specialists when planning lessons.

Finding: 65% of teachers have never visited another teacher's classroom to observe teaching.

Finding: Only 58% of Minnesota science teachers meet with other teachers to discuss science teaching at least once a month. One in three do this twice a year or less often.

Other findings of interest:

Finding: 40% of Minnesota eighth grade science teachers never or rarely assign a writing assignment as homework.

Finding: Three-fourths of eighth grade science teachers say that it is very important that students understand how science is used in the real world, yet only one in three teachers asks students to use what they've learned as a homework assignment.

Finding: Minnesota science teachers spend an average of 15 hours per week beyond the school day preparing, grading, planning, meeting with parents and students, professional reading or development, keeping student records and other administrative tasks. This is greater than the U.S. average of 13 hours per week.

Conclusions:

Minnesota teachers and students should be proud of their science achievement in TIMSS. This snapshot of eighth grade achievement is an indication of dedicated, well prepared teachers and students who value learning. But the world is quickly changing and we must change with it. Everyone needs to be able to use scientific information at work and in daily life. The National Science Education Standards and the Minnesota Graduation Standards provide a vision and a course for us as we move toward science literacy for all students. Achieving this vision means that we must expect teaching and learning for understanding and application of rigorous science content. Current science courses, as they exist today, will not allow our students to develop the knowledge and skills necessary for success in the future.

We have only begun to analyze the TIMSS data on science achievement in Minnesota. Our preliminary analysis suggests that emphasis should be given to the following two points as we work toward improving science participation and achievment for ALL Minnesota students:

- While the Minnesota average score is high, there is also a lot of variability in the scores. About one third of Minnesota students do not meet the international median in science achievement. In addition, girls' achievement is lower than that of boys. These issues must be addressed through policies and professional development that will support and enable all teachers and all students to perform at high levels.

- The education system must support the teaching and learning of scientific inquiry by providing adequate materials and facilities along with appropriate curriculum and assessments. Teachers must be provided with time, resources, and professional development to rethink and rework science programs with regard to what they teach, when and how they teach, and how they measure student learning.

Figure 9. Gender Differences in Eighth Grade Mean Achievement Scores in Third International Mathematics and Science Study (TIMSS)

	Mathematics		Science	
	Boys	Girls	Boys	Girls
Minnesota	527	524	573	557*
U.S.	502	497	539	530
Singapore	642	645	612	603

* Indicates Statistically Significant Difference

Figure 10. Eighth Grade Students' Reports On Whether They And Their Friends Agree That It Is Important To Do Various Activities (Percentages Agreeing)

	MN		US		SINGAPORE		JAPAN	
	Self	Friends	Self	Friends	Self	Friends	Self	Friends
Do Well in Science	94	71	96	69	99	96	87	83
Do Well in Mathematics	97	77	97	75	99	97	92	90
Have Time to Have Fun	99	98	99	98	96	96	99	99
Be Good At Sports	88	90	88	90	89	86	83	81

SOURCE: IEA Third International Mathematics and Science Study, 1994-95.

Figure 11. Summary of Participation Data In Minnesota TIMSS Testing (March-May 1995)

	Total Schools Participating	Total Students
All populations	135	4,999
Performance Assess.	84	748
Grade 4	47	1,950
Performance Assess.	41	365
Grade 8	44	1,949
Performance Assess.	43	383
Grade 12	44	1,100

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CONCLUSIONS: WHAT CAN MINNESOTA LEARN FROM TIMSS?

- TIMSS shows that student learning is strongly influenced by what's taught and how it's taught; this is born out in the apparent differences between math and science achievement in the Minnesota TIMSS scores.

- The strong TIMSS performance of countries with system-wide standards and highly-focused curriculum and instruction affirms the potential value of Minnesota's Graduation Standards for focusing curriculum and instruction statewide.

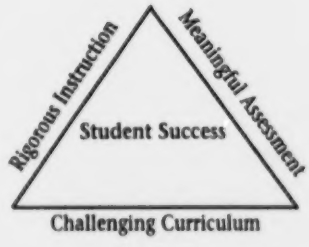
- Minnesota's strong performance in science suggests the power of aligning curriculum and instruction system-wide, but also reminds us that the current goal of science education (learning facts and procedures) does not align with the vision of science education reform (inquiry and problem solving.)

- Although mathematics and science teachers in Minnesota are generally better prepared to teach than their U.S. colleagues on average, the conditions they teach under and their opportunities for professional development and peer support significantly limit their ability to implement the ideas in the national and state standards.

- The TIMSS results must be understood in the context of the full range of reports (all three grade levels tested) and in comparison with other measures of assessment (such as the U.S. NAEP mathematics and science tests) which provide a more detailed look at the diversity of student achievement in Minnesota schools.

As the U.S. Department of Education observed about the international results, *"TIMSS is not an answer book, but a mirror through which we can see our own education system in international perspective."* Careful study of the unique data available in the Minnesota TIMMS results will assist educators, parents, the business community, and policy-makers in implementing the Minnesota Graduation Standards and achieving the vision of mathematics and scientific literacy for all students.

TIMSS SHOWS THE MOST IMPORTANT FACTORS IN IMPROVING STUDENT ACHIEVEMENT ARE A FOCUS ON WHAT WE TEACH, HOW WE TEACH IT, AND HOW WE MEASURE IT.



RECOMMENDATIONS FOR CHANGE IN POLICY AND PRACTICE

Based on Minnesota's performance in the Third International Mathematics and Science Study (TIMSS), SciMath^{MN} recommends the following actions for improving science and mathematics education in Minnesota:

RECOMMENDATIONS FOR IMPROVEMENTS IN WHAT WE TEACH:

- Use the national mathematics and science education standards to guide further development of the Minnesota Graduation Standards (in mathematics and science), and the Minnesota K-12 mathematics and science Curriculum Frameworks to assist districts in focusing their curriculum and instruction.

- Include algebra and geometry in the Minnesota basic standards test to meet international standards for eighth grade mathematics content.

RECOMMENDATIONS FOR IMPROVEMENTS IN HOW WE TEACH:

- Emphasize tighter focus in district curricula and greater rigor, as well as real-world applications, in teaching the Minnesota high standards and the use of assessment packages.

- Fund, plan and implement a coordinated and coherent statewide professional development program to orient teacher training around implementing the standards.

- Align teacher licensure and teacher education programs to support effective implementation of the Minnesota Graduation Standards and their call for inquiry-based teaching and learning.

RECOMMENDATIONS FOR IMPROVEMENTS IN HOW WE MEASURE:

- Align statewide testing with the Gradation Standards and include more demanding items (such as open-ended questions or student-constructed response problems) on the statewide tests.

- Analyze curriculum, instruction, and assessment practices to insure that all students, particularly those who have been under served in mathematics and science education previously, receive adequate opportunity to learn.

- Provide funding and incentives for local alignment with statewide standards and assessment. Create and implement a statewide continuous improvement plan.

FOR FURTHER INFORMATION ABOUT TIMSS...

For U.S. TIMSS Information:

- National Library of Education 1-800-424-1616
- National Center for Educational Statistics 1-202-219-1804
- NCES U.S. TIMSS Internet site http://www.ed.gov/NCES/timss
- Boston College U.S. TIMSS Internet site http://wwwcsteep.bc.edu/timss
- Michigan State University U.S. TIMSS Internet site http://ustimss.msu.edu

For Minnesota TIMSS Information:

- Call SciMath^{MN} at 612-296-4058
- E-mail scimath-mn@informns.k12.mn.us
- Visit the SciMath^{MN} Internet site at http://www.informns.k12.mn.us/scimathmn

Timeline for Release of Additional U.S. and Minnesota TIMSS Reports:

Spring 1997

- Release of complete Minnesota TIMSS Report (expanded version of this preliminary summary) by SciMath^{MN}.

Summer 1997

- Release of fourth grade international results; Minnesota release to follow.
- Release of international achievement on performance items; Minnesota release to follow.

Fall 1997

- Release of twelfth grade international results; Minnesota release to follow.

ABOUT SCIMATH^{MN}...

Founded in 1993, SciMath^{MN} is a partnership among business, education and state government pursuing statewide improvement in the teaching and learning of K-12 mathematics and science based on the national mathematics and science education standards. SciMath^{MN}'s mission is to increase the educational achievement and participation of all Minnesota students in science and mathematics to help them meet the complex challenges of their future.

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